

WHAT IS CLAIMED IS:

1           1. A ferromagnetic semiconductor composition, comprising:  
2           a substrate layer; and  
3           a ferromagnetic semiconductor epilayer formed on the substrate, said epilayer  
4 defining a plane and having a cubic hard axis;  
5           wherein a voltage transverse to said cubic hard axis is detectable in response  
6 to an applied current flow along the cubic hard axis.

1           2. The composition of claim 1, wherein the application of an in-plane  
2 magnetic field, non-aligned with the cubic hard axis, produces a transition in the transverse  
3 magnetic resistance of the epilayer.

1           3. The composition of claim 1, wherein the applied in-plane magnetic  
2 field is sufficiently strong such that the transition is substantially abrupt.

1           4. The composition of claim 1, wherein the substrate is a GaAs substrate,  
2 and wherein the epilayer includes Mn doped GaAs ((Ga, Mn)As)).

1           5. The composition of claim 4, wherein the concentration ratio of Ga to  
2 Mn in the epilayer is approximately 948 to 52.

1           6. The composition of claim 4, wherein the concentration ratio of Ga to  
2 Mn is between approximately 100:1 and 100:8.

1           7. The composition of claim 1, wherein the substrate is selected from the  
2 group consisting of GaAs and GaN.

1           8. The composition of claim 1, wherein the epilayer is selected from the  
2 group consisting of Mn doped GaAs and Mn doped GaN.

1           9. The composition of claim 1, wherein the substrate includes a buffer  
2 layer formed thereon and disposed between the substrate and the epilayer.

1           10. The composition of claim 9, wherein the buffer layer includes p-type  
2 GaAs.

1           11. The composition of claim 10, wherein the p-type GaAs is Be doped  
2         GaAs.

1           12. The composition of claim 10, wherein the epilayer includes Mn doped  
2         GaAs.

1           13. The composition of claim 12, wherein the buffer layer is  
2         approximately 300 nm thick and wherein the epilayer is approximately 150 nm thick.

1           14. The composition of claim 1, wherein the epilayer is between  
2         approximately 10 nm thick and approximately 350 nm thick.

1           15. The composition of claim 1, wherein the epilayer is formed by  
2         molecular beam epitaxy.

1           16. A ferromagnetic semiconductor device, comprising:  
2         a substrate defining a plane;  
3         a ferromagnetic semiconductor epilayer formed on said substrate, said epilayer  
4         being substantially elongated and oriented along a cubic hard axis; and  
5         first and second electrical contacts, each contact coupled to an end of the  
6         elongated epilayer, said contacts being configured to provide an electrical current flow along  
7         the hard axis;  
8                 wherein application of an electrical current flow along the hard axis produces  
9         a voltage substantially transverse to said hard axis.

1           17. The device of claim 16, further including first and second transverse  
2         voltage probes coupled at opposite sides of the elongated epilayer, said first and second  
3         probes being substantially equidistant from an end of the epilayer, wherein said voltage  
4         probes detect said transverse voltage responsive to said current flow.

1           18. The device of claim 16, further including a plurality of transverse  
2         voltage probe pairs, each pair including a probe coupled at opposite sides of the epilayer,  
3         each pair defining a voltage detection region substantially perpendicular to the cubic hard  
4         axis.

1               19.     The device of claim 16, wherein application of an in-plane magnetic  
2     field, non-aligned with the cubic hard axis, produces a transition in the transverse magnetic  
3     resistance of the epilayer.

1               20.     The device of claim 19, wherein the applied magnetic field is  
2     sufficiently strong such that the transition is substantially abrupt..

1               21.     The device of claim 16, wherein the substrate is a GaAs substrate, and  
2     wherein the epilayer includes Mn doped GaAs ((Ga, Mn)As)).

1               22.     The device of claim 21, wherein the concentration ratio of Ga to Mn in  
2     the epilayer is approximately 948 to 52.

1               23.     The device of claim 21, wherein the concentration ratio of Ga to Mn is  
2     between approximately 100:1 and 100:8.

1               24.     The device of claim 16, wherein the substrate is selected from the  
2     group consisting of GaAs, and Mn doped GaN.

1               25.     The device of claim 16, wherein the epilayer is selected from the group  
2     consisting of Mn doped GaAs and Mn doped GaN.

1               26.     The device of claim 16, wherein the substrate includes a buffer layer  
2     formed thereon and disposed between the substrate and the epilayer.

1               27.     The device of claim 26, wherein the buffer layer includes p-type GaAs.

1               28.     The device of claim 27, wherein the p-type GaAs is Be doped GaAs.

1               29.     The device of claim 27, wherein the epilayer includes Mn doped GaAs.

1               30.     The device of claim 16, wherein the epilayer is between approximately  
2     10 nm thick and approximately 350 nm thick.

1               31.     The device of claim 16, wherein the epilayer is formed by molecular  
2     beam epitaxy.

1                   32. A method of measuring magnetic domain wall parameters in  
2 ferromagnetic-semiconductor materials, comprising:

3                   providing a test sample including a ferromagnetic semiconductor epilayer  
4 formed on a substrate, said epilayer being substantially planar and having a cubic hard axis  
5 and being substantially elongated;

6                   providing a current flow along the cubic hard axis; and

7                   detecting a transverse voltage in the epilayer responsive to said current flow at  
8 each of a plurality of transverse voltage probe pairs in contact with the epilayer, each pair  
9 having probes in contact with the epilayer on opposite sides relative to the cubic hard axis.

1                   33. The method of claim 32, further comprising applying an in-plane  
2 magnetic field to the test sample.

1                   34. The method of claim 33, wherein said applied magnetic field is non-  
2 aligned with the cubic hard axis.

1                   35. The method of claim 33, wherein the applied field is fixed in  
2 magnitude, and wherein applying includes sweeping the orientation of the magnetic field  
3 relative to the cubic hard axis.

1                   36. The method of claim 35, wherein sweeping includes sweeping the  
2 magnetic field by  $2\pi$ .

1                   37. The method of claim 33, further including applying a saturation field to  
2 the test sample before applying the in-plane magnetic field.

1                   38. The method of claim 34, wherein the applied field is fixed in  
2 orientation relative to the cubic hard axis, and wherein the magnitude of the applied magnetic  
3 field is altered.

1                   39. The method of claim 32, further including processing the transverse  
2 voltages detected by the transverse voltage probe pairs so as to determine one or more  
3 parameters associated with a magnetic domain wall in the epilayer.

1                   40. The method of claim 39, wherein the one or more parameters include  
2 one of domain wall velocity and transverse magnetic resistance.

1                  41.        The method of claim 32, wherein the substrate is a GaAs substrate, and  
2        wherein the epilayer includes Mn doped GaAs ((Ga, Mn)As)).

1                  42.        The method of claim 41, wherein the concentration ratio of Ga to Mn  
2        in the epilayer is approximately 948 to 52.

1                  43.        The method of claim 41, wherein the concentration ratio of Ga to Mn  
2        is between approximately 100:1 and 100:8.

1                  44.        The method of claim 32, wherein the substrate is selected from the  
2        group consisting of GaAs and GaN.

1                  45.        The method of claim 44, the epilayer is selected from the group  
2        consisting of Mn doped GaAs and Mn doped GaN.

1                  46.        The method of claim 32, wherein the sample includes a buffer layer  
2        formed between the substrate and the epilayer.

1                  47.        The method of claim 32, wherein the substrate is a type III-V  
2        semiconductor.

1                  48.        The method of claim 47, wherein the epilayer is a type III-V  
2        semiconductor doped with Mn.

1                  49.        The composition of claim 1, wherein the substrate is a type III-V  
2        semiconductor.

1                  50.        The composition of claim 49, wherein the epilayer is a type III-V  
2        semiconductor doped with Mn.

1                  51.        The device of claim 16, wherein the substrate is a type III-V  
2        semiconductor.

1                  52.        The device of claim 51, wherein the epilayer is a type III-V  
2        semiconductor doped with Mn.